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AUTHOR Ware, William B.; Garber, Malcolm
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ABSTRACT

The primary object of this research proposal is to delineate the area of general learning abilities. It differentiates between abilities and skills by defining ability as a general trait which can be inferred from observation of responses consistent across tasks and skill as a proficiency on a specific task or on a limited group of tasks. A review of the literature revealed the following general types of references related to general learning abilities: general references, theories of human abilities, organization of human abilities, and relation of abilities to performance. The study proposes three classes for the organization of human abilities -- cognitive, perceptual-motor, and physical. It also identifies, defines and illustrates broad categories within each class. Cognitive processes include cognition, memory, convergent production, divergent production, and evaluation. Perceptual motor responses include sensory, spatial relationships, speed of movement, coordination, dexterity, and movement discrimination. Physical processes include strength and flexing. An appendix diagrams this organization. (DJ)

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General Learning Abilities

A Survey of the State of the Art and A Proposed Organization of Human Learning Abilities

Principal Investigator: William B. Ware, University of Florida
Co-Investigator: Malcolm Garber, University of Florida

Final Report

Project No. 1.15

Division of Elementary and Secondary Education
Department of Education
State of Florida

June 30, 1972

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PREFACE

In preparing this final report, an effort has been made to comply with the requirements of the letter of agreement made between the State Department of Education and the Division of Sponsored Research, University of Florida. One exception is that resource personnel and programs were not actually contacted, but they were identified as indicated in Appendix B. This exception was made because there was a delay of one month in the approval of funds.

The annotated bibliography as specified in the letter of agreement has been provided in the second part of the report, in the review of literature. The domain chart as specified in the agreement is presented in Appendix C.

A large amount of literature was reviewed in preparation of this final report. In view of the extent of the work in this area, the requirement that reports like this be capable of being read and assimilated in twenty minutes or less seems overly restrictive. However, if one wishes to familiarize himself with the area in such a short time, it is suggested that he first study the abstract and then proceed directly to the proposed organization in Part III. From there he may go to Appendix C for the domain charts.

A serious student of general learning ability may wish to read the entire final report.

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ABSTRACT

The primary object of this research proposal was to delineate the area of general learning abilities. Early in the search of the literature a definition was found that differentiated between "abilities" and "skills." An ability is defined as a general trait, the existence of which can be inferred from observation of responses consistent across tasks. In contrast, a skill is defined as a proficiency on a specific task or on a limited group of tasks.

The review of the literature revealed several general types of references related to general learning abilities. Among the topics identified were general references, theories of human abilities, the organization of human abilities, studies relating abilities to performances, and references related to general abilities, but not clearly related to any of the previous topics. The general references included textbooks, previous reviews, and books of readings. Theoretical approaches to human abilities have been concerned with the origins of ability, the nature of the interrelationships among abilities, and the development of abilities. Other approaches to human abilities have been directed toward the classification of general learning abilities. Some attempts at classification have been logical while others have been empirical. Most references identified were treatments of either cognitive or psychomotor abilities. Very few references acknowledged the area of affective abilities, and none treated this area very extensively.

Studies exploring the relationships between selected abilities and performance have examined such matters as verbalization, memory, concept

formation, classification, problem solving, perceptual organization, and perceptual motor skills. In addition several miscellaneous references were related to affective variables, personality variables, experiential variables, age variables, and general views of abilities.

Drawing upon the references identified in the review of literature an organization of general learning abilities was proposed and a domain chart prepared, based upon the proposed organization.

PART I

TECHNICAL REPORT

The funds for supporting this particular research were cleared through the Division of Sponsored Research, University of Florida, and the State Department of Education on April 1, 1972. At the time the proposal was submitted, the anticipated date of clearance was March 1. Because of the one month delay, it was not possible to complete all of the activities proposed (specified in the letter of agreement) before the project deadline. For this reason, it is important to outline in some detail the activities which have led to the writing of this report.

Before funds were obtained, the coinvestigators identified those areas in both Psychological Abstracts and Education Index which seemed to hold premise for the initial search of the literature. A listing of these topics is included in Appendix A. On April 1, two graduate assistants were employed and assigned to alternate volumes of Psychological Abstracts. A third graduate assistant was employed and assigned to Education Index. It became readily apparent that progress was much slower than had been anticipated. The students had been instructed to begin with the 1960 volumes; after two weeks the procedures were reversed and the review was conducted on the most current volumes. One of the greatest difficulties encountered was the students' initial inability to discriminate relevant from irrelevant material.

While the students struggled through the abstracts, the coinvestigators searched the ERIC files manually. Identifiers used were Ability, Affective, Basic Skills, Cognitive, Learning, Psychomotor, Study Skills, and Taxonomies. On May 1, the graduate assistants were assigned to check out the ERIC leads,

while the coinvestigators organized the references from the abstracts provided by the students. From this point in the research, it is very difficult to specify precisely what occurred. The entire team attacked the primary sources, and a period of searching, cross-referencing, and searching continued for the rest of the month of May. A card file was maintained centrally in order to keep all members of the team informed and to prevent a duplication of effort.

Near the end of May, the coinvestigators began to sift through the accumulated materials in an attempt to bring some sort of organization to the field. The month of June was spent organizing, writing, and rewriting the final report. During this period, graduate assistants were helpful in tracking down obscure references and offering constructive criticism of the report. Also during this time, potential resource programs and personnel were identified. Because of the lack of time, these potential resources have only been identified, but not directly contacted. A listing of these resources has been included in Appendix B. It is suggested that contact not be made directly until decisions are made concerning the future nature of the "General Learning Abilities" Program in the State of Florida. Such decisions could influence who should be contacted and for what purpose.

The remainder of this final report presents the substantive findings of the research project. The survey of the literature is presented in annotated form in Part II. The literature has been organized around the topics of general references, theoretical positions, organization of abilities, relationship between abilities and performance, and miscellaneous topics. On the basis of the literature reviewed, an attempt was made to organize the domain into some sort of manageable structure. Such a structure was to have included divisions, subdivisions, etc., down to, but not including the level

of objectives. An attempt was made to comply with those specifications. In addition, examples (or manifestations) of the abilities identified have been included.

PART II

REVIEW OF LITERATURE:
An Annotated Bibliography

Introduction

The topic of human intelligence and ability has been a popular one which has generated a tremendous amount of literature. In undertaking to complete a comprehensive review of the literature related to general, human learning abilities, the primary task was to define the object of the search. In initiating this review of the literature, a provisional definition of "general learning abilities" was employed. That definition was, in effect, that general learning abilites were those attributes within an individual which facilitate future learning. While admittedly weak, that definition served as a vehicle to begin the overview of the literature. The initial review supplied a much more useful definition of general learning ability (Fleishman, 1967a, 1967b; Parker and Fleishman, 1960). Over a period of time a definition of ability has consistently evolved; this definition appears most appropriate for use in defining "general learning abilities." Parker and Fleishman (1960) defined ability as a general, stable trait of an individual which should facilitate performance on a range of tasks. Fleishman (1967a, 1967b) has made a distinction between ability and skill. An ability has been viewed as a general trait, the presence of which may be inferred from observation of response consistencies. In contrast, a skill may be defined as a proficiency on a specific task or on a limited group of tasks. The word "ability" is used in this report in the sense as defined above. This definition is consistent with the concerns voiced by Humphreys (1962) and McNemar (1964) both of whom cautioned that it was an easy matter to continuously split "factors" until ability might be fragmented into too many specific factors of too little importance.

Much human effort has been spent in the study of human ability. Inherent in the definition given above is a suggested methodology for studying the nature of human ability. A historical perspective should reveal that the study of ability and the development of the techniques of factor analysis have grown together. As a statistical tool, factor analysis is designed to examine interrelationships among variables and to identify constellations of similar response patterns. A method with such properties is well suited for identifying "factors" common to different tasks, and thus has been extremely helpful in the identification of general abilities.

Even though the technique of factor analysis has been central in the identification of general learning abilities, methodological studies of factor analysis were not included in the present review because they were considered tangential. Precedence for omitting methodological studies concerning factor analysis has been established by Ferguson (1965), Fleishman and Bartlett (1969), and Tyler (1972). Several major topics were identified in the literature review which is presented in this text. These topics included General References, Theories of Human Ability, Organization of Human Abilities, Studies Relating to Performance, and Miscellaneous Articles. A detailed consideration of each topic follows.

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References:

Fleishman, E. A. Development of a behavior taxonomy for describing human tasks: A correlational-experimental approach. Journal of Applied Psychology, 1967, 51, 1-10. (a)

Fleishman, E. A. Performance assessment based on an empirically derived task taxonomy. Human Factors, 1967, 9, 349-366. (b)

Humphreys, L. G. The organization of human abilities. American Psychologist, 1962, 17, 475-483.

McNemar, Quinn. Lost: Our intelligence? Why? American Psychologist, 1964, 19, 871-882.

Parker, J. F., Jr., and Fleishman, E. A. Ability factors and component performance measures as predictors of complex tracking behavior. Psychological Monographs, 1960, 74, No. 503.

General Reference Works

Introduction

During the course of the review, a number of reference works were identified which should be of interest to the student of human abilities. Included in these works were textbooks, reviews, and books of readings.

Bibliography

Cattell, Raymond B. Abilities: Their Structure, Growth, and Action. Boston: Houghton Mifflin Company, 1971.

In this comprehensive treatment of the field of intelligence and related fields, Cattell takes the position that there is currently a rekindling of interest in the study of ability. Much of the book is built upon a two-factor (crystallized and fluid) theory of intelligence, although Cattell has predicted a movement toward a three factor theory of intelligence, in which personality and motivation are incorporated as a third factor. The reference to affective factors of ability was one of the few found. Cattell has taken the position that although intelligence is an important attribute, possession of it does not ensure success.

DeCecco, John P. The Psychology of Learning and Instruction: Educational Psychology. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1968.

This book is an excellent textbook for a first or second course of Educational Psychology. A general, but ample, treatment of the development of intelligence is presented in Chapter 4. This reference might serve as a good overview of the field for the beginner.

Dockrell, W. B. (ed.) On Intelligence. Toronto: The Ontario Institute for Studies in Education, 1970.

This volume presents a number of articles by leading authorities in the field. These articles were presented as papers at the Toronto Symposium on Intelligence.

Ferguson, G. A. Human abilities. Annual Review of Psychology, 1965, 16, 39-62.

A comprehensive review of the literature covering the period from 1960 to early 1964, in which a good part of the discussion relates to strengths and weaknesses of theoretical approaches.

Flavell, John H. The Developmental Psychology of Jean Piaget. New York: D. van Norstrand Company, Inc., 1963.

A book written to present a clear picture of the work of Piaget to people of various levels of sophistication. The Introduction and Chapter 1 present an integrated overview of Piaget's systematic approach.

Fleishman, E. A., and Bartlett, C. J. Human abilities. Annual Review of Psychology, 1969, 20, 349-380.

In this review covering the period from early 1964 through early 1968, the authors reemphasize the distinction between ability and skill which was discussed earlier. Much of the review is devoted to looking at literature concerning the organization of abilities.

Pinneau, Samuel R., and Jones, Harold E. Development of Mental Abilities. Review of Educational Research, 1958, 28, 392-400.

This review reflects the increasing interest in theoretical issues related to the organization and development of mental abilities. Special attention is paid to cross-sectional studies which have helped clarify the relationship of various factors to individual differences in ability. Sixty-eight references are included.

Scheerer, M. Cognitive theory. In Lindzey, G. (ed), Handbook of Social Psychology. Cambridge, Massachusetts: Addison Wesley Publishing Company, Inc., 2 vols., 1954, 91-142.

A good review of the psychological issues surrounding the S-R vs. cognition controversy. Several cognitive theories were summarized, but very little was said relating directly to learning abilities.

Tyler, Leona E. Human abilities. Annual Review of Psychology, 1972, 23, 177-206.

This review contains well over 200 references covering the period from early 1968 to late 1970. This period has been characterized as one of revolt against traditional notions of IQ. Learning ability is viewed as different from intelligence in this review devoted largely to a discussion of Guilford's model.

Wiseman, Stephen (ed.). Intelligence and Ability: Selected Readings. Baltimore, Maryland: Penguin Books Inc., 1967.

A handy reference of selections by classic names in intelligence theory. Topics include: early theories, defining intelligence, the structure of the mind, and the nature versus nurture controversy.

Wolfe, D. (ed.). The Discovery of Talent. Cambridge, Massachusetts: Harvard University Press, 1969.

This volume was mentioned several times in the literature as being an outstanding collection of readings, but, unfortunately, was unavailable at the University of Florida.

Theories of Human Ability

Introduction

Much of the effort directed into the study of human abilities has been channeled into theoretical considerations. Issues which seem to have received much attention in the literature are the origins of intelligence, the nature of interrelationships among human abilities, and the development of abilities. The concern over the origin of intelligence has been manifested in the heredity-experience controversy. Concern with the nature of organization is evidenced by the many different views of intelligence. Spearman (1904, 1927) viewed intelligence as a general factor in combination with a multitude of specific abilities. Multifactor theories have been presented by Thurstone (1938), Horn (1968), Jensen (1963, 1969), Jensen and Rohwer (1970), and Cattell (1963). Hierarchical theories have been presented by Burt (1955), Vernon (1950), and Gagne (1968). Matrix-facet theories have been considered by Guilford (1959), Humphreys (1962), and Schlesinger and Guttman (1969).

Concern with the development of intelligence is typified in the work of Jean Piaget and also evident in the theories of Ferguson (1954) and Gagne (1968).

Bibliography

Galton, Sir Francis. Hereditary Genius. London: MacMillan, 1892.

In this classic work, the author expressed an objection to the notion of natural equality. He argued that individual differences in ability, determined by heredity, are enormous and postulated that the distribution of human ability followed a normal distribution.

Hunt, J. McV. Intelligence and Experience. New York: Ronald Press Company, 1961.

As the title might suggest, Hunt has assembled evidence against the notion that intelligence is fixed, and not subject to modification by experience. Hunt has argued that while genetics may fix some very broad limits, experience plays a central role in the development of patterns of cognitive ability.

Spearman, C. "General Intelligence": Objectively determined and measured. American Journal of Psychology, 1904, 15, 201-292.

After defining four different methods to measure intelligence, the author presented a series of correlational analyses. On the basis of the results, it was concluded that there exist a general sensory discrimination and a general intelligence and that the two correspond closely.

Spearman, C. The Abilities of Man. London: MacMillan, 1927.

This volume contains an explanation of g, the general factor of intelligence. As g is seen as a universal component of all tasks, variability in performance across tasks is explained as a function of specific factors.

Kelley, T. L. Crossroads in the Mind of Man. Stanford: Stanford University Press, 1928.

The author presented arguments against Spearman's theories, thus signaling a major breakaway of the American theorists from the Spearman tradition. Kelley advocated studying many traits simultaneously and listed a number of factors which warranted study. Furthermore, Kelley suggested that there were possibly three factors contained in Spearman's g: maturity, verbal, and residual.

Thurstone, L. L. Primary mental abilities. Psychometric Monographs. Chicago: University of Chicago Press, 1938, No. 1.

A classic study which appeared to identify a number of equally important factors. This finding seemed to be the end of Spearman's notion of g.

Jensen, Arthur. Learning ability in retarded, average, and gifted children. Merrill-Palmer Quarterly, 1963, 9, 123-140.

In this paper, Jensen suggested that learning was not a single, unitary ability, but rather was composed of a number of relatively independent dimensions. The results of this particular study indicated that "labeling" behavior and the effects of verbalization on learning were worthy of further study.

Jensen, Arthur R. Intelligence, learning ability, and socioeconomic status. Journal of Special Education, 1969, 3, 23-35.

In this article, Jensen has differentiated between associative and conceptual abilities, designated Level I and Level II, respectively. Furthermore, it is suggested that these two abilities are differentially distributed across socioeconomic levels.

Jensen, Arthur R., and Rohwer, William D., Jr. An experimental analysis of learning abilities in culturally disadvantaged children. Final Report, Office of Economic Opportunity, Contract No. OEO 2404, July, 1970.

The distinction between Level I and Level II learning abilities is maintained. Level I is characterized as the ability to receive or register stimuli, store them, and later recall them. Level II is described as the transformation or manipulation of the stimulus prior to the response.

Cattell, Raymond B. Theory of fluid and crystallized intelligence: a critical experiment. Journal of Educational Psychology, 1963, 54, 1-22.

In this article, the author has argued for a general factor theory of intelligence, but identifies two general factors rather than one. Crystallized intelligence is seen as skilled habits which result from the process of earlier learning. Fluid intelligence is seen as the ability to perform tasks which require adaptation to new situations. Results of a study were reported to support the theory.

Horn, John L. Organization of abilities and the development of intelligence. Psychological Review, 1968, 75, 242-259.

Horn developed a theory of abilities extending the work of Cattell (1963). The main interest of this theory is with the method of differentiation between crystallized and fluid intelligence. Crystallized intelligence is seen as the product of a process of acculturation, in which individual differences will increase with age. Fluid intelligence is viewed as related to genetic factors, neurological factors, and incidental learning.

Burt, C. L. The evidence for the concept of intelligence. British Journal of Educational Psychology, 1955, 25, 158-177.

After presenting both non-statistical and statistical evidence for the construct of intelligence, Burt took the position that an individual's potential may be predetermined, but that many other factors have an impact on specialized abilities. The other factors would include the health and emotional qualities of the individual.

Burt, C. L. The structure of the mind: a review of the results of factor analysis. British Journal of Educational Psychology, 1949, 19, 100-111.

Burt reviewed the literature, organizing the review around the topics of Cognitive Processes (Sensory, Perceptual, Associative, Higher Relational) and Emotional Factors. The evidence from the literature was used to present a hierarchical view of ability structure, in contrast to both Spearman's unitary concept and Thurstone's primary abilities concept.

Vernon, P. E. The Structure of Human Abilities. London: Methuen, 1950, Chapters 2 and 3.

While conceding that there is probably something like g, Vernon maintained that there was some sort of structure beyond a unitary, inherited quantity. Two major group factors were identified: v:ed (verbal, numerical, and educational) and k:m (practical, mechanical, spatial, and physical). It was noted that these two group factors could be further subdivided. It was suggested that the nature of v:ed is fairly well culturally standardized, while k:m is less well standardized.

Gagne, Robert M. Contributions of learning to human development. Psychological Review, 1968, 75, 177-191.

Gagne has taken the position that within limitations imposed by growth, behavioral development results from the cumulative effects of learning. The theories of Gesell and Piaget are contrasted to the alternate idea that learning plays a major factor in development. This important role is seen as effected through the processes of differentiation, recall, and transfer.

Guilford, J. P. Three faces of intellect. American Psychologist, 1959, 14, 469-479.

A presentation of the classic matrix-model of intellect in which the bases for classification are processes (cognition, memory, convergent thinking, divergent thinking, and evaluation); context (figural, symbolic, semantic, behavioral); and products (units, classes, relations, systems, transformations, and implications).

Humphreys, L. G. The organization of human abilities. American Psychologist, 1962, 17, 475-483.

In this article, Humphreys discussed the limitations and advantages of both the hierarchical (Vernon) and matrix-facet (Guilford, Guttman) models of intelligence. The discussion is aimed at the undue proliferation of mental tests, and Humphreys expressed the opinion that the matrix-facet models are better suited for reducing an excessive number of tests.

Schlesinger, I. M., and Guttman, L. Smallest space analysis of intelligence and achievement tests. Psychological Bulletin, 1969, 71, 95-100.

This paper contrasts smallest space analysis with factor analysis and finds the former to be more parsimonious. Data from another study were reanalyzed; the results presented indicate that the six factors could be represented in two-space. These results are interpreted in support of a facet (matrix) definition of intelligence.

Jensen, Arthur R. Hierarchical theories of mental ability. In Dockrell, W. B. (ed.) On Intelligence. Toronto: The Ontario Institute for Studies in Education, 1970, pp. 119-190.

In this paper Jensen discussed and gave examples of the major types of theories of intelligence. Included were: Taxonomic (Guilford), Factor Hierarchies (Burt, Vernon), Learning Hierarchies (Gagne), Ontogenetic Hierarchies (Piaget).

Humphreys, L. G. Critique of Cattell's "Theory of fluid and crystallized intelligence: a critical experiment." Journal of Educational Psychology, 1967, 58, 129-136.

In reacting to Cattell's 1963 study in which evidence for the higher order factors of fluid and crystallized intelligence was reported, Humphreys criticized the original study on the basis of methodological weaknesses. Humphreys proposed a simpler methodological approach which appeared less ambiguous. The results of Humphreys' analysis support Cattell's theory, but are also consistent with Vernon's hierarchical theory.

Ferguson, George A. On learning and human ability. Canadian Journal of Psychology, 1954, 8, 95-112.

A theory of human ability was presented focused on the development of abilities. The theory indicates that principles of learning, particularly transfer, can be used to explain the manner in which specific skills are combined to form general abilities. Essentially, the role of ability in subsequent performance is conceptualized as a problem of transfer.

Flavell, John H. The Developmental Psychology of Jean Piaget. New York: D. van Norstrand Company, Inc., 1963.

This volume served as a reference for Piaget's theory of intelligence. Piaget has worked extensively with both the structure and function of intellect. Although intelligence is viewed as the extension of some fundamental biological characteristics, the intellect is able to overcome the limitations imposed by biological structures by the manner in which it functions. The interaction with the environment (adaptation) generates new structures, although the method of functioning is constant (invariant). The central ideas in the theory are Content, Function, and Structure. Piaget's primary concern has been with the changes in structures, which are partitioned into stages in a hierarchical arrangement.

Inhelder, Barbel, and Piaget, J. The Growth of Logical Thinking from Childhood to Adolescence. New York: Basic Books, 1958.

This book offers a parallel analysis of the development of language and thought, suggesting that growth in logical thinking is in a large measure tied to growth in language capacity.

Bruner, J. J. The course of cognitive growth. American Psychologist, 1964, 19, 1-15.

Bruner has stressed the importance of internalizing language, and its subsequent importance in representing and systematically transforming the outer experience symbolically.

Whyte, Lillian A. The development of classification ability in children of below average intelligence. Dissertation Abstracts International, 1970, 30, 4700-4701.

The development of classification and logic was traced in children below average intelligence. The results indicate that subaverage children seem to follow a pattern of development similar to average children.

Burt, C. L. Differentiation of intellectual ability. British Journal of Educational Psychology, 1954, 24, 76-90.

The author noted that, with increasing age, intellectual ability tends to become more specialized.

Organization of Human Abilities

Introduction

In addition to theoretical expositions, the literature is rich in content dealing with the classification of human abilities. If one accepts the premise that there is, in fact, some identifiable set of human abilities, then one should be concerned with the seemingly myriad of different classification systems which have been offered and supported with empirical evidence. However, given the nature of psychological measure and an understanding of the methods used to derive and substantiate the various systems, such concern can be somewhat alleviated. First, one must understand that psychological measurement is by its very nature inferential. Psychometricians cannot observe directly what it is they attempt to measure, but rather must infer the quantity of the measured attribute from observing a sample of behavior. Thus, the classification of abilities is in part a function of the specific measuring instruments employed. A second factor which can account for differences among classification systems is the method of derivation. Some systems have been derived through rational logic, while others have been the result of empirical investigations employing factor analytic techniques. Systems logically derived may vary as a function of the theoretical biases of the logician and the purpose for which the system was prepared. Systems empirically derived may vary as a function of the factor analytic method selected and the sample of behaviors examined. Small wonder that a student of the literature has so many options from which to choose a system of classification.

This review of the literature indicated several broad types of literature available: treatments of cognitive abilities, treatments of psychomotor abilities, and articles attempting to make some sense out of the systems of classification available. The bibliography has been organized along this scheme.

Bibliography

Thurstone, L. L. Primary mental abilities. Psychometric Monographs, Chicago: University of Chicago Press, 1938, No. 1.

Using a centroid factor analytic solution, Thurstone identified a number of "primary mental abilities:" Spatial (visual), Perceptual, Numerical, Verbal Relations, Word Fluency, Memory, and Inductive. Two other factors were tentatively identified as Arithmetic Reasoning and Deductive.

French, J. W. The description of aptitude and achievement tests in terms of rotated factors. Psychometric Monographs, 1951, No. 5.

This monograph contains a comprehensive analysis of aptitude and achievement test results on adolescent and adult subjects. The results of 69 separate analyses were reported. More than 50 factors were identified. The factors were presented alphabetically by label with a description of each.

White, Sheldon H. The hierarchical organization of intellectual structures. (Paper presented at the annual convention of the American Association for the Advancement of Science, Washington, D.C., December, 1966).

In this discussion of the assumptions made about the composition of intelligence, evidence was presented for the emergence of a factor at age 5 which may become the principal determinant of intelligence through adulthood. This factor was described by such terms as "provisional action," "planning," and "abstract behavior."

Vernon, P. E. Ability factors and environmental influences. American Psychologist, 1965, 20, 723-733.

A model of abilities based on g with associated major and minor group factors was presented. After a rotation of centroid factors to remove g, the residual correlations appeared to define two broad factors. The first factor was designated as "Verbal-Educational" and was comprised of such abilities as reading, spelling, linguistic and clerical abilities, Fluency and divergent production. The second factor was labeled "Spatial-Practical-Mechanical" and included the following abilities: psychomotor, physical, mechanical information, spatial abilities, mathematical abilities, and scientific and technical abilities.

Burt, C. The structure of the mind: a review of the results of factor analysis. British Journal of Educational Psychology, 1949, 19, 100-111.

Burt reviewed the literature and presented an organization of human abilities as follows:

Sensory (Sight, hearing, smell, touch and kinaesthesis)
Perceptual (General sense perception, motor capacity)
Intermediate
    Formal (Memory, productive association)
    Content (Imagery, verbal ability, arithmetical ability, practical ability)
Higher Relational (Comprehension of relations, combination of relations, aesthetic)
General (Receptive and executive functions) Speed, Attention
Emotional (Assertive, inhibitive)

Bloom, Benjamin S., Englehart, Max D., Furst, Edward, Hill, Walter H., and Krathwohl, David R. Taxonomy of Educational Objectives, Handbook I: Cognitive Domain. New York: David McKay Co., Inc., 1956.

This interesting volume resulted from an effort to construct a taxonomy of educational outcomes based upon an educational-logical psychological classification system. Six major categories of cognitive function were incorporated into the hierarchical system: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

Gagne, Robert M. The acquisition of knowledge. Psychological Review, 1962, 69, 355-365.

Knowledge is acquired through the building of more and more complex learning sets, acquired through transfer. Learning is dependent upon recall of subordinate learning sets and upon the effects of instructions.

Gagne, Robert M. The Conditions of Learning. New York: Holt, Rinehart and Winston, 1965.

Gagne has presented a hierarchy of eight types of learning: Signal, Stimulus-response, Chaining, Verbal Associate, Multiple Discrimination, Concept, Principle, and Problem Solving.

Gagne, Robert M., and Paradise, N. E. Abilities and learning sets in knowledge acquisition. Psychological Monographs, 1961, 75, 1-23, No. 14.

The results of research undertaken to identify a hierarchy of learning sets were reported. The results seem to support the notion of different levels of the hierarchy being associated with different levels of task variables.

Gagne, Robert M. Elementary science: A new scheme of instruction. Science, 1966, 151, 49-53.

This article contains a brief description of materials prepared under the support of AAAS and NSF. The materials were designed to teach children the processes of science and deal with the following topics: Observation, Classification, Communication, Number Relations, Measurement, Space-time Relations, Prediction, Inference, Formulating Hypotheses, Making Operational Definitions, Controlling and Manipulating Variables, Experimenting, Formulating Models, and Interpreting Data.

Anderson, R. C., and Ausubel, David P. (eds.) Readings in the Psychology of Cognition. New York: Holt, Rinehart, and Winston, Inc., 1965.

The use of language in thinking involves far more than simple use of labels. Language plays an important role in acquisition of insight. The use of language in generating new abstract propositions makes it possible for thought to reach a level much higher than is possible without language.

Green, R. F., Guilford, J. P. et al. A factor-analytic study of reasoning abilities. Psychometrika, 1953, 18, 135-160.

A battery of 32 tests was factor analyzed using Thurstone's centroid method. The results included twelve interpretable factors: Verbal comprehension, Numerical facility, Perceptual speed, Visualization and Spatial orientation, General reasoning, Logical reasoning, Education of perceptual relations, Education of conceptual relations, Education of conceptual patterns, Education of correlates, and Symbol substitution.

Wilson, R. C. and Guilford, J. P. et al. A factor-analytic study of creative-thinking abilities. Psychometrika, 1954, 19, 297-311.

A factor analysis (Thurstone's Centroid method) of 53 tests designed to measure aspects of creative thinking resulted in 14 factors. Nine factors had been previously identified: Verbal comprehension, Number facility, Perceptual speed, Visualization, General reasoning, Word fluency, Associational fluency, and a combination of Thurstone's Closure I and II. Five new factors were identified: Originality, Redefinition, Adaptive flexibility, Spontaneous flexibility, and Sensitivity to problems.

Guilford, J. P. The structure of intellect. Psychological Bulletin, 1956, 53, 267-293.

After listing 40 intellectual factors which had been identified, Guilford attempted to formulate a system into which the factors could be placed. He came up with a matrix having empty cells, representing hypothesized factors.

Kettner, N. W., Guilford, J. P., and Christenson, J. P. A factor analytic study across the domains of reasoning, creativity, and evaluation. Psychological Monographs, 1959, 73, No. 9.

The main purpose of the study was to investigate certain factors found previously in the domains of reasoning, creativity, and evaluation. Nine of eleven factors studied emerged in a form similar to previous forms. Five new factors were identified: Perceptual classification, Education of structural relations, Naming abstractions, Education of conceptual correlates, and Penetration.

Guilford, J. P. Factors that aid and hinder creativity. Teachers' College Record, 1962, 63, 380-392.

Contained in this article are adequate descriptions of the general factors (Cognition, Memory, Convergent, Divergent, and Evaluation) and their subcategories. Guilford took the position that creativity (Divergent Production) is made up of many components: Fluency factors, Flexibility factors, and Elaboration.

Guilford, J. P. Intelligence: 1965 model. American Psychologist, 1966, 21, 20-26.

The article is in essence a progress report. The Structure of Intellect (SI) model was much the same in 1965 as it was in 1958: A cube of 5 operations X 4 contexts X 6 products. Also contained was a report on identifying the 120 abilities. At that time about one-half of the cells were "full."

Stott, Leland H., and Ball, Rachael S. The identification and assessment of thinking ability in young children. Final Report: U.S. Department of Health, Education, and Welfare, Office of Education, Bureau of Research, 1968.

This research concerned the thinking abilities of 4-5 year old children using Guilford's model of the human intellect. The findings of the research included 6 specific sorts of abilities: ability to organize spatial systems, speediness in spatial modeling, ideational fluency, originality, general reasoning ability, and fine muscular control.

Whitehall, Richard P., and Redding, Juliette L. Learning skills and information organization. Wisconsin University Counseling Center Reports, Vol. 3, No. 10, ERIC No. ED 040408, 1970.

This report described a learning skills program based on an organization model. The model is comprised of five parts: Input, Short-term memory, Organization and Consolidation, Long-term memory, and Recall.

Evans, Glen T. Intelligence, transfer, and problem-solving. In Dockrell, W. B. (ed.). On Intelligence. Toronto: The Ontario Institute for Studies in Education, 1970, pp. 191-231.

In this paper, the author has attempted to define learning goals by pulling together the work of several authorities. Association is defined in terms of Bloom's Knowledge and Gagne's first five levels. Comprehension is defined with Bloom's Application and Comprehension, Gagne's Concept Learning and Principle Learning, and Ausubel's Advanced Organizers. Problem solving is defined in the sense of Ausubel and Gagne.

Warburton, F. W. The British intelligence scale. In Dockrell, W. B. (ed.). On Intelligence. Toronto: The Ontario Institute for Studies in Education, 1970, pp. 71-98.

In this paper, the author has described a proposed form of the scale. A number of subscales have been considered: Reasoning, Verbal, Spatial, Number, Memory, and Fluency. Drawing upon the work of Burt, Thurstone, and Guilford, a contents X mental processes model is proposed. The processes are as follows: Perception, Memorization, Recognition, Conceptualization, Convergent Reasoning (classification), Convergent Reasoning (operational), and Divergent Reasoning.

Hunt, E. B. Concept Learning: An Information Processing Problem. New York: Wiley, 1962.

In bringing together the empirical and theoretical contributions of psychology and computing science, the author achieved an excellent treatment of problem solving. Factors of interest include Stimulus Organization and Complexity, Memory, and Strategies of Information Processing.

Kelley, H. P. Memory abilities: A factor analysis. Psychometric Monographs, 1964, No. 11.

A highly recommended reference, but not available through the University of Florida Library system.

Guilford, J. P. A system of psychomotor abilities. American Journal of Psychology, 1958, 71, 164-174.

Guilford developed a matrix system for classifying psychomotor abilities isolated by Fleishman and Hempel. The matrix involves the type of ability and the parts of the body involved.

Simpson, Elizabeth. Classification of educational objectives: Psychomotor domain. University of Illinois, Urbana, ERIC No. 010368, 1966.

After dealing with the matter of classification of educational objectives, the author includes a system of classification of psychomotor behavior based upon: perception, set, guided response, mechanism, and complex overt response.

Fleishman, Edwin A. Dimensional analysis of psychomotor abilities. Journal of Experimental Psychology, 1954, 48, 437-454.

This study was one of a series designed to provide a functional classification of abilities in the psychomotor domain. Thirty-eight apparatus and printed psychomotor tests were administered. The tests had been selected in congruence with the hypothesized factors. The analysis resulted in the identification of twelve factors: Wrist-Finger Speed, Finger Dexterity, Rate of Arm Movement, Aiming, Arm-Hand Steadiness, Reaction Time, Manual Dexterity, Psychomotor Speed, Psychomotor Coordination, Spatial Relations, Postural Discrimination, and Hand Precision Aiming.

Fleishman, Edwin A., and Hempel, W. E. A factor analysis of dexterity tests. Personnel Psychology, 1954, 7, 15-32.

The study employed 15 widely used printed and apparatus dexterity tests. The intercorrelation matrix was factor analyzed and five factors were obtained: Finger Dexterity, Manual Dexterity, Wrist-Finger Speed, Aiming, and Positioning.

Fleishman, Edwin A., and Hempel, W. E. Factor analysis of complex psychomotor performance and related skills. Journal of Applied Psychology, 1956, 40, 96-104.

Twenty-three tests were administered to over 1,000 subjects. Thurstone's Centroid method of factor extraction and an orthogonal rotation of factor structure resulted in the following factors: Psychomotor Coordination I, Psychomotor Coordination II, Spatial Relations I (Stimulus interpretation), Spatial Relations II (Response choice), Integration, Rate Control, Perceptual Speed, Manual Dexterity, and Visualization. The

results were interpreted to mean that there are broad group factors of psychomotor abilities which may account for performance on a wide variety of psychomotor tasks.

Fleishman, Edwin A., and Ellison, Gaylord D. A factor analysis of fine manipulative skills. Journal of Applied Psychology, 1962, 46, 96-105.

Twelve apparatus and nine printed tests were administered to 760 subjects. The results were intercorrelated and factor analyzed. The factors identified were: Manual Dexterity, Finger Dexterity, Speed of Arm Movement, Wrist-Finger Speed, and Aiming.

Fleishman, Edwin A. Factor structure in relation to task difficulty in psychomotor performance. Educational and Psychological Measurement, 1957, 17, 522-532 (b).

In this study of the effects of varying the difficulty of perceptual-motor tasks on the aptitudes measured by the tasks, a number of factors were identified. Those included were: Spatial Orientation, Visualization, Response Orientation, and Perceptual Speed.

Nicks, Delmer C., and Fleishman, Edwin A. What do physical fitness tests measure? - A review of factor analytic studies. Educational and Psychological Measurement, 1962, 22, 77-95.

In this article a review of factor analytic studies in physical fitness was measured. A summary indicated the following breakdown:

Strength (Explosive, Dynamic, Static)
Flexibility (Extent, Dynamic)
Balance (Static, Dynamic, Balancing Objects)
Coordination (Multiple Limb, Gross Body)
Endurance

Fleishman, Edwin A. Factor analyses of physical fitness tests. Educational and Psychological Measurement, 1963, 23, 647-661.

This article reports a number of studies carried out to clarify the limits of previous factors identified, sharpen factor definitions, and isolate tests which measured the factors. In one study analyzing strength tests, several factors were identified: Dynamic Strength, Static Strength, Explosive Strength, Trunk Strength, and Weight Strength. Another analysis of speed, flexibility, balance, and coordination indicated a number of factors: Explosive Strength, Gross Body Balance, Dynamic Flexibility, Balance-Visual Cues, Extent Flexibility, and Speed of Limb Movement.

Fleishman, Edwin A. The Structure and Measurement of Physical Fitness. Englewood Cliffs, New Jersey: Prentice-Hall, 1964.

This volume contains a critical analysis of 100 tests of physical proficiency. Two factor analyses were completed and nine primary factors identified: Static Strength, Explosive Strength, Dynamic Strength, Trunk Strength, Extent Flexibility, Dynamic Flexibility, Gross Body Coordination, Equilibrium, and Stamina.

Hilsendager, D., Karnes, E., and Spiritoso, T. Some dimensions of physical performance. Perceptual and Motor Skills, 1969, 28, 479-487.

A factor analytic study of motor skills performance indicated that basic variables included: body size, agility, movement speed, reaction time, dynamic strength, and balance (coordination).

Flower, R. The evaluation of auditory abilities in the appraisal of children with reading problems. In Figurel, A. (ed.). Perception and Reading. Newark, Delaware: International Reading Association, 1968, pp. 21-24.

In this brief article, a systematic hierarchy of auditory skills was proposed. Theoretically, this hierarchy should be mastered before reading instruction is offered.

McNinch, George. Auditory preceptual factors and measured first-grade reading achievement. Reading Research Quarterly, 1971, 6, 472-492.

This study was designed to test the existence of the auditory perceptual skill hierarchy as postulated by Flowers (1968). The evidence suggested that the hierarchy does not exist in relation to reading achievement.

Gagne, Robert M. Domains of learning. (Paper read at the annual meeting of the American Educational Research Association, New York, February, 1971).

Although addressing himself to the planning of educational research, Gagne did point out five areas of learning: motor skills, verbal information, intellectual skills, cognitive strategies, and attitudes.

Metheny, Eleanor. Meaning, movement, and the cognitive domain. (Speech presented to the Physical Education division of the AAHPER, Washington, D.C., May, 1964).

A position paper asserting that the psychomotor domain has been misnamed. After being renamed the "effective" domain, the area is divided into the psycho-effective and somato-effective.

Mussen, Paul H., Conger, J. J., and Kagan, J. Child Development and Personality. New York: Harper & Row, Publishers, 1963.

Within this excellent "child development" text, a section was devoted to human ability. The first division was into Intellectual Skills and Perceptual Skills. Intellectual Skills included Vocabulary, Syntax, and Articulation. Perceptual Skills were divided into Differentiation, Acquired Distinctiveness, Whole-part Perception, and Spatial Orientation.

Safrit, Margaret J. The structure of gross motor skill patterns. University of Wisconsin, ERIC No. 010102, 1966.

This research effort was directed toward an examination of gross motor skills. Three alternate patterns (factor structures) were hypothesized: the extremity used, types of projection, and a complicated classification system. The results indicated that the empirical factor structures were unlike the hypothesized patterns.

Fleishman, Edwin A. Performance assessment based on an empirically derived task taxonomy. Human Factors, 1967, 9, 349-366.

In this paper, the author presented an extensive discussion of ability research. Suggestions were made for conducting a massive research program on task taxonomies. Among the suggested procedures were: a rational analysis of the real tasks, a synthesis and testing of naturalistic tasks, a definition of behavior categories by factor analysis, and performance forecasting.

Fleishman, Edwin A. Development of a behavior taxonomy for describing human tasks: A correlational-experimental approach. Journal of Applied Psychology, 1967, 1-10.

This article is a shorter version of the Human Factors presentation. After distinguishing between a skill and an ability, the author presented an encapsulated view of his research program on psychomotor abilities. Eleven psychomotor factors and nine physical fitness factors were described which appeared regularly. The psychomotor abilities were Control Precision, Multilimb Coordination, Response Orientation, Reaction Time,

Speed of Arm Movement, Rate Control, Manual Dexterity, Arm-Hand Steadiness, Wrist-Finger Speed, and Aiming. The physical fitness factors cited were Extent Flexibility, Dynamic Flexibility, Static Strength, Dynamic Strength, Explosive Strength, Trunk Strength, Gross Body Coordination, Gross Body Equilibrium, and Stamina.

Foster, Harriet. Categories of Cognitive Skills. University of California, Los Angeles, ERIC No. 013974, 1966.

A comparison of different classification systems was presented, using Guilford's model as a basis. Strengths and weaknesses of various systems are discussed.

Roberts, D. M. Abilities and learning: A brief review and discussion of empirical studies. Journal of School Psychology, 1969, 7, 12-21.

After a synthesis of research on learning abilities was presented, it was concluded that there are several dimensions of abilities. The topics discussed included: Relationships between aptitude measures and learning task performance, verbal learning, psychomotor learning, and concept formation. The author has concluded that verbal learning, rote learning, concept learning, and speed-precision may be among the several kinds of learning.

Farina, Alfred J., Jr. Development of a taxonomy of human performance: A review of descriptive schemes for human task behavior. Washington, D.C.: American Institutes for Research, 1969.

A number of schemes for describing human behaviors were reviewed. Generally, available schemes were characterized as lacking for reasons of imprecise terms, inadequate measurement capacity, etc.

Theologus, George C., Romashko, Tania, and Fleishman, Edwin A. Development of a taxonomy of human performance: A feasibility study of ability dimensions for classifying human tasks. Washington, D.C.: American Institutes for Research, 1970.

This manuscript should be read by anyone concerned with the classification of human abilities. An original list of 49 abilities was selected on the basis of work by Guilford, French, and Fleishman. These abilities covered the domains of cognitive, psychomotor, and physical behavior. Empirical testing resulted in a reduction of the list to 37 abilities, accompanied by definitions.

The Relationship Between Selected Abilities and Performance

Introduction

While much effort has been spent in attempting an organizational scheme for classifying human abilities, other investigators have invested their energies in exploring the relationships between selected abilities and performance on a variety of measures. A number of such studies were identified during this review of literature. The studies identified have been classified into several broad categories for purposes of reporting here. These categories include Verbalization, Memory, Concept Formation, Classification, Problem Solving, Perceptual Organization, Perceptual Motor Skills, and General. In most instances the classification of a particular study was determined by considering the main independent variable discussed.

Bibliography

Blount, William R. Concept-usage performance: Abstraction ability, number of referents, and item familiarity. American Journal of Mental Deficiency, 1971, 76, 125-129.

Twenty-five EMR subjects were compared with 22 nonretarded subjects, matched for MA and SES. No evidence of differences was found in abstraction ability or on measures of the number of referents. However, nonretarded subjects were able to label appropriately more of the concept classes.

Gagne, Robert M., and Smith, E. C. A study of the effects of verbalization on problem solving. Journal of Experimental Psychology, 1962, 63, 12-18.

The results of this investigation seemed to suggest that requiring students to verbalize during practice encouraged them to think of new reasons for their moves. This appeared to facilitate the discovery of general principles and their employment in solving successive problems.

Wolff, Joseph L. Effect of subject-determined verbalization on discrimination learning in preschoolers. Journal of Educational Psychology, 1969, 60, 261-266.

A non-reversal shift discrimination paradigm was employed with 80 preschool subjects. Half of the subjects named the stimulus, while half did not. The results indicated that verbalization facilitated the acquisition of brightness discrimination ($p < .01$) but not the discrimination of size.

Stones, E. Verbal labeling and concept formation in primary school children. British Journal of Educational Psychology, 1970, 40, 245-252.

The standard Vigotsky sorting task and labeled, specially constructed extension tasks were administered to thirty primary school children. Thirty control S's were given identical tasks with the nonsense labels removed. Subjects using labeled materials did significantly better on extension tasks.

Robinson, James P., and London, Perry. Labeling and imagining as aids to memory. Child Development, 1971, 42, 641-644.

The results indicated that verbal labels must be appropriate in order for verbal processes to facilitate learning of visual stimuli. It was also suggested that naming may be particularly helpful early in learning.

Randhawa, B. S. Intellectual development and the ability to process visual and verbal information. AV Communication Review, 1971, 19, 298-312.

Information handling and process capacities in humans were studied as a function of input model and output products. It was concluded that the problems in processing information are primarily those involved in translations in and out of different mediums, i.e., language problems.

Peters, Donald L. Verbal mediators and cue discrimination in the transition from nonconservation to conservation of number. Child Development, 1970, 41, 707-721.

The role of verbal mediators in comparison and cue discrimination was studied. The results indicated that verbal training led to superior performance on immediate learning, and also led to significantly better retention.

Pavio, Allan, and Foth, Dennis. Imaginal and verbal mediators and noun concreteness in paired associate learning: The elusive interaction. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 384-390.

Undergraduate students generated mediators for 30 concrete or 30 abstract noun pairs. In each case, one-half of the pairs were linked by nonverbal images and one-half by verbal mediators. Results of a recall test suggested an interaction: imagery produced better recall on concrete pairs while verbal mediation was more effective for abstract pairs.

Murdock, Bennet B. Response-factors in learning and transfer. American Journal of Psychology, 1960, 73, 355-369.

A series of six experiments was presented in support of the hypothesis that verbal responses are superior to motor responses as mediators in learning and transfer.

Lemke, E. A., Klausmeier, H. J., and Harris, C. W. Relationship of selected cognitive abilities to concept attainment and information processing. Journal of Educational Psychology, 1967, 58, 27-35.

Scores from 16 tests, 2 each for 8 abilities (General Reasoning, Verbal Comprehension, Induction, Deduction, Spatial Scanning, Perceptual Speed, Rote Memory, and Span Memory) and scores from 18 concept-attainment and information processing tasks were intercorrelated and factor analyzed. The results indicated that Verbal Comprehension, General Reasoning, and Induction correlated consistently with concept-attainment and information processing factors.

Lloyd, Kenneth E. Supplementary Report: Retention and transfer of responses to stimulus classes. Journal of Experimental Psychology, 1960, 59, 206-207.

The variable identified as contributing to the transfer results was whether or not the class name was ever used as a mediating response.

Deno, Stanley L Jenkins, Joseph R., and Marsey, Judy. Transfer variables and sequence effects in subject-matter learning. Journal of Educational Psychology, 1971, 62, 365-370.

The results of this study suggested that learning to identify and label attributes of a concept influences subsequent performance using the concept.

Fredrick, W. C., and Klausmeier, H. J. Instructions and labels in a concept attainment task. Psychological Reports, 1968, 23, 1339-1342.

Specific instructions to attain a concept resulted in significantly better performance than did instructions merely indicating the attributes. A meaningful label attached to each figure resulted in better concept attainment than did a nonsense label. It was theorized that the instructions and meaningful labels facilitated accurate categorization.

DiVesta, Francis J., and Ricards, John P. Effects of labeling and articulation on the attainment of concrete, abstract, and number concepts. Journal of Experimental Psychology, 1971, 88, 41-49.

The results were interpreted to suggest that labeling functions as an encoding mechanism and that articulation increases the saliency of the appropriate code for the task.

Carey, J. E., and Goss, A. E. The role of mediating verbal responses in the conceptual sorting behavior of children. Journal of Genetic Psychology, 1957, 90, 69-74.

The experimental hypothesis of positive transfer from verbal learning to learning to sort was confirmed for the group using familiar words, but not for the group using nonsense syllables as labels. The reasons for this outcome and the bases of children's inferiority to adults in both verbal learning and conceptual sorting were discussed.

Blank, Marion, and Bridger, Wagner H. Deficiencies in verbal labeling in retarded readers. ERIC No. 034659, 1966.

The results indicated that the difficulty that retarded readers experienced was not simply cross modal transfer but rather in applying relevant verbal labels to the stimuli within the same sense modality.

Anderson, Richard C. Control of student mediating processes during verbal learning and instruction. Review of Educational Research, 1970, 46, 349-369.

Literature pertinent to the thesis that the activities in which a student engages influences what he will learn is presented. Several lines of evidence are interpreted to indicate that learning is facilitated when the task requires meaningful processing.

Krebs, George E. Verbal labels and stimulus complexity in acquisition of recognition and reproduction of visual forms. Dissertation Abstracts International, 1970, 30, 5714.

Initial strength and derived patterns of form-name relationships and complexity and goodness of the forms were the variables, and whether or not form-name relationships had been acquired were then related to acquisition of recognition and reproduction of the forms.

Kezheradze, E. D. [The role of the word in memorization and some features of memory in the child] Vop. Psikhol., 1960, No.1, 78-85.

Results suggested that best memorization occurs when the material is easily named, and naming is the goal of memorization.

Shuell, Thomas J., and Keppel, Goeffrey. Learning ability and retention. Journal of Educational Psychology, 1970, 61, 59-65.

These experiments were conducted in relation to the hypothesis that differences in learning ability may not be a function of differences in memory. The results suggest that individual differences in long-term retention are at best minimal, when subjects are equated for the degree of original learning.

Roodin, Marlene L., and Gruen, Gerald E. The role of memory in making transitive judgments. Journal of Experimental Child Psychology, 1970, 10, 264-275.

Students given a memory aid made more transitive judgments and correct verbal explanations at every age level.

Houston, J. P. Short term retention of verbal units with equated degrees of learning. Journal of Experimental Psychology, 1965, 70, 75-78.

It was found that short-term retention of five-word units was significantly better than retention of six-word units when degrees of learning had been equated through manipulation of presentation times. A further discussion of short-term memory is contained.

Gregory, S. C., Jr., and Bunch, M. E. The relative retentive abilities of fast and slow learners. Journal of General Psychology, 1959, 60, 173-181.

Slow and fast learners were compared on basis of immediate retention, and retention after 24 hours. Fast learners showed a slight, consistent, but nonsignificant superiority in retention for an interval of 24 hours.

Coleman, J. C., and Rasof, B. Intellectual factors in learning disorders. Perceptual and Motor Skills, 1963, 16, 139-152.

Underachievers were found to score low on WISC subtests heavily loaded with school-type learning, concentration, and memory factors. However, these students made high scores on subtests loaded with perceptual organization and informal learning.

Cahill, Hugh, E., and Houland, Carl I. The role of memory in the acquisition of concepts. Journal of Experimental Psychology, 1960, 59, 137-144.

In this study on the acquisition of concepts, individual differences suggested that students who made more "perceptual-inference" and memory errors had greater difficult in acquiring concepts.

Razik, T. A. Concepts and concept learning. Theory Into Practice, 1971, 10, 95-143.

A comprehensive discussion of concepts and their acquisition is presented. The position is taken that concepts are important as they permit classification, labeling, and the ordering of objects and events. It is further noted that memory plays an important role in concept learning.

McCullough, Constance M. Implications of research on children's concepts. Reading Teacher, 1959, 3, 100-107.

Definitions, process of formation and factors influencing concept development were summarized. Children must be able to form concepts before they can learn to read.

Klausmeier, H. J., and Meinke, D. L. Concept attainment as a function of instructions concerning the stimulus material, a strategy, and a principle for securing information. Journal of Educational Psychology, 1968, 59, 215-222.

Six groups comprised a 2 x 3 factorial design in which instructions were varied in two ways. One factor was giving a principle vs. not giving the principle. The other factor varied the amount of information: A conservative focusing strategy, a description of the structure of the stimulus material, and minimum information. Concept attainment was more efficient for the three groups receiving the principle. The rank order of the other factor was Strategy more effective than Structure more effective than minimum information.

Klausmeier, H. J., and Frayer, Dorothy A. Operations in concept learning. Research and Development Center for Learning, University of Wisconsin, ERIC No. 045467, 1970.

Three operations were stressed as being fundamental in concept attainment: Attending to the situation (whole and components), searching the instances for common elements, and processing and using information.

Lemke, E. A., Tagatz, G. E., and Meinke, D.L. The relationship between conceptual learning and curricular achievement. Journal of Experimental Education, 1969, 38, 70-75.

The relationship between performance on concept attainment and information processing tasks and performance on selected curricular achievement tests was examined using factor analytic procedures. The results indicated that information processing and concept attainment of exemplar information were related to curricular factors.

Bruner, J. S., Goodnow, J. J., and Austin, G. A. A Study of Thinking. New York: Wiley, 1956.

Concept "attainment" is contrasted to "formation." Attainment is described as the search for, and testing of attributes which may serve in distinguishing items of various categories. The authors have taken the position that most cognitive activity depends upon the ability to categorize.

Coppolino, Ida S. Classification abilities as related to instruction and achievement in early adolescence. U. S. Department of Health, Education, & Welfare, Office of Education, Final Technical Report, Contract No. OE-6-10-305,1967.

The ability of junior high students to classify semantic information according to operations hypothesized by Guilford was examined. Findings indicated that classification demands a kind of analytic behavior which is related to achievement in math, history, vocabulary, and reading comprehension.

Resnick, Lauren B. et al. Classification skills. University of Pittsburgh: Learning Research and Development Center, ERIC No. 043088, 1970.

Twenty-seven kindergarten children were trained on two different double classification matrix tasks. Some Ss learned the easier task followed by the harder task. The remaining Ss learned the tasks in the reverse order. The results indicated that Ss who learned the easier task first learned the more complex task in fewer trials. The subjects who learned the hard task first acquired the simple task in the process.

Wetherick, N. E., and Murray, M. R. Inductive thinking capacity and academic performance in secondary school children. Research in Education, 1970, 4, 42-48.

The results of this study were interpreted to suggest that reasoning ability may be the main determinant of the ability to acquire knowledge.

Simon, Roger I. Encoding effects on complex problem solving. Journal of Experimental Psychology, 1970, 83, 227-231.

Results from this study indicated that there were differences between the problem-solving processes used in the abstract and meaningful domains. Abstract problem solving may have entailed a greater and more rapid exploration of the set of available decision alternatives.

Cross, K. P., and Gaier, E. L. Technique in problem solving as a predictor of educational achievement. Journal of Educational Psychology, 1955, 46, 193-206.

It was noted that problem solving requires knowledge of fundamental facts and their effective utilization. The results of the study indicated that the use of principles was more effective in problem solving than is the use of facts.

Ausubel, David P. The use of advanced organizers in the learning and retention of meaningful verbal material. Journal of Educational Psychology, 1960, 51, 267-272.

The hypothesis is presented to the effect that learning and retention of unfamiliar but meaningful verbal material can be facilitated by the advance introduction of relevant concepts (organizers). The results of an experiment were presented in support of this hypothesis.

Ausubel, D. P. Cognitive structure and the facilitation of meaningful verbal learning. Journal of Teacher Education, 1963, 14, 217-221.

If the existing cognitive structure is clear, stable and organized appropriately, the learning of new meaningful material may be facilitated. In turn, the acquisition of appropriate cognitive organization seems to depend on two factors: (1) Using concepts and principles in a given discipline that have the widest explanatory power, inclusiveness, generalizability, etc., and (2) Employing methods of presenting and ordering the sequence of subject matter that enhance the clarity, etc. of the cognitive structure.

Bergan, John R., Zimmerman, Barry J., and Ferg, Maureen. Effects of variations in context and stimulus grouping on visual sequential memory. Journal of Educational Psychology, 1971, 62, 400-404.

The results of this study are interpreted in relation to what Jensen has called associate learning. Such learning is influenced by memory storage capacity and also by the manner which stimuli are grouped for recall [perceptual organization].

Ookan, Robert; Weiner, Morton; and Cromer, Ward. Identification, organization, and reading comprehension of good and poor readers. Journal of Educational Psychology, 1971, 62, 71-78.

The results of this study failed to support the assumption that good identification is sufficient for reading comprehension. Instead, it is suggested that the comprehension difficulties of poor readers may be attributed to the manner in which input is organized.

Allan, Mary D. Memorizing, recoding, and perceptual organization. British Journal of Psychology, 1961, 52, 25-30.

Perceptual organization was found to be a basis activity of the communication system under conditions of stress. Stress was induced by repeatedly bombarding channels with a sequence of events too numerous for immediate absorption.

Kress, Roy A. Reading disability: Cognitive factors. Proceedings of the Annual Reading Institute, 1968, 7, 47-52.

It is asserted that the manner in which the child is able to process raw materials for learning may determine the degree of ability or disability in reading.

Bibace, Roger, and Hancock, Karen. Relationships between perceptual and conceptual cognitive processes. Journal of Learning Disabilities, 1969, 2, 17-29.

In a test of the assumption that mastery of perceptual-motor skills is necessary prior to acquisition of higher cognitive processes, it was found that some students with low motor-perceptual ability were able to achieve well in school. It was concluded that the assumption must be qualified.

Hurwitz, Charlotte. Visual discrimination in the pre-school child - An aspect of reading readiness. Dissertation Abstracts International, 1971, 32, 240.

The results found that very young children could be trained to discriminate letter pairs. No relationships were found between the ability to discriminate letters and the measures of IQ and mental age.

Pedder, Donald. Discrimination abilities and motor skills in relation to reading. Dissertation Abstracts International, 1971, 32, 252.

The relationship of visual-motor skills to reading achievement was explored. The major finding was that the Bender Gestalt test, in conjunction with intelligence, was able to predict reading achievement. Another finding was that perceptual speed, form discrimination, form constancy, and integrated visual motor skills were related to intelligence.

Arnold, Richard D. Auditory discrimination abilities of disadvantaged Anglo- and Mexican-American children. Elementary School Journal, 1970, 70, 295-299.

The author reported that children who have poor auditory discrimination abilities are more likely to have difficulty with reading.

Starnes, David R. Visual abilities vs. reading abilities. Journal of the American Optometric Association, 1969, 40, 596-600.

A pilot study investigating the relationship between reading problems and visual-perceptual abilities found no relationship between a single visual ability and a single perceptual ability. It was concluded that these functions are complex and interrelated.

Patrinakou, Elpis D. A study of the effect of motor perceptual training on cognitive abilities in slow learning children with implications for educational planning. Dissertation Abstracts International, 1970, 31, 2220.

Analysis of the data suggested that a training program in motor perception resulted in superior performance on cognitive and motor tasks at the conclusion of the training program for slow learning children.

Fisher, Maurice D., and Turner, Robert V. Analysis of effect of perceptual-motor training program on cognitive and motor development of disadvantaged children. Proceedings of the Annual Convention of the American Psychological Association, 1970, 5, 649-650.

Disadvantaged kindergarten children received systematic perceptual-motor training during a year in school. The results showed these children performing significantly better than a control group on the Metropolitan Readiness Test.

Trembly, Dean. Clerical speed: The visual dexterity factor in learning. Academic Therapy, 1971, 7, 15-20.

Results were interpreted as showing that visual dexterity (perceptual speed, ocular motility) is related to vocational and academic success.

Locke, John L. Acoustic imagery in children's phonetically mediated recall. Perceptual and Motor Skills, 1971, 32, 1000-1002.

The results of this study suggested that phonetic mediation is functionally related to the ability to form acoustic images to nonphonetic stimuli and to detect similarities among the images.

Cassity, Russel. Factors affecting the mediational function of imagery in 5th grade children. Dissertation Abstracts International, 1971, 32, 1329-1330.

Among the factors affecting imagery were sex of child, cueing method, amount of information (size of chunk) provided, and method of presentation of the material.

Robertson, Anne D. The relationship of visual imagery to operational thinking in children. Dissertation Abstracts International, 1970, 31, 2966.

The relationship between operational thinking and visual imagery was examined. The data supported the hypothesis that imagery performance is a function of operational level.

Cawley, John F., et al. Reading and psychomotor disability among mentally retarded and average children. University of Connecticut, ERIC No. 046654, 1968.

Selected elements of reading and psychomotor characteristics among good and bad readers. Results indicated that good and poor readers could be differentiated on measures of reading. However, they were differentiated infrequently on measures of psychomotor characteristics (auditory discrimination, visual word discrimination, visual perception, etc.).

Wachtel, Paul L. Cognitive style, attention, and learning. Perceptual and Motor Skills, 1971, 32, 315-318.

The results were discussed in terms of the greater ability of field independent individuals to extract aspects of experience from embedded context (selective attention).

MacKintosh, N. J. Selective attention and response strategies as factors in serial reversal learning. Canadian Journal of Psychology, 1969, 23, 335-346.

Results of the study suggest that selective strengthening of attention to a single relevant dimension is one factor underlying rapid reversal learning.

Anderson, Richard C. An analysis of a class of problem-solving behavior. University of Illinois, Final Report, Contract No. OEC-5-10-299, 1968.

Two factors, spatial orientation and figural adaptive flexibility, revealed modest correlations with measures of problem-solving performance. It was concluded that ability in dealing with spatial configurations plays a role in performance on concept attainment problems.

Asch, Solomon E.; Hay, John; and Diamond, Rhea. Perceptual organization in serial rote learning. American Journal of Psychology, 1960, 73, 177-198.

A number of different spatial arrangements of one list of nonsense syllables were constructed. Differences in arrangements produced differences in rate of learning, patterns of remote errors, and other typical effects. The results were interpreted as demonstrating the importance of spatial factors in serial learning.

Hinrichs, J. R. Ability correlates in learning a psychomotor task. Journal of Applied Psychology, 1970, 54, 56-64.

A battery of psychomotor tests was subjected to factor analysis. Previous findings of both increasing and decreasing task-specific factors in the acquisition of a psychomotor task were replicated. The results draw attention to the difficulties in predicting proficiency in motor from basic ability measures.

Fleishman, E. A. A comparative study of aptitude patterns in unskilled and skilled psychomotor performances. Journal of Applied Psychology, 1957, 41, 263-272 (a).

A comparison of abilities involved at early and late stages of practice on a variety of complex psychomotor tasks indicated considerable (but systematic) changes in the patterns of abilities related to proficiency at various stages of practice.

Fleishman, Edwin A., and Rich, Simon. Role of kinesthetic and spatial-visual abilities in perceptual-motor learning. Journal of Experimental Psychology, 1963, 66, 6-11.

The results confirmed and extended earlier work, showing that the abilities related to learning early in practice may be different from those which facilitate later learning.

Alvares, Kenneth M. The effects of complex skill acquisition on measures of ability. Dissertation Abstracts International, 1971, 31, 7657.

In an attempt to examine the finding that correlations between ability measures and performance decrease with time and/or practice, the results indicated that the changing-task, changing subject model is the most accurate representation of the skill acquisition process.

Roberts, Dennis M.; King, F. J.; and Kropp, Russell P. An empirical investigation of Ferguson's theory of human abilities. Canadian Journal of Psychology, 1969, 23, 254-267.

A study was designed to test four hypotheses derived from Ferguson's theory of human abilities. Several hypotheses were confirmed. The two instructional methods showed different patterns of correlations with abilities over stages of practice and differential transfer. The evidence also showed differential learning, learning-how-to-learn, and an increasing trend of task-specific variance over practice trials.

Rosenberg, Sheldon. Problem solving and conceptual behavior. In Ellis, N. R. (ed) Handbook of Mental Deficiency. New York: McGraw-Hill, 1963, pp. 439-462.

A survey of literature showed that mentally deficient people have lower ability in concept formation, problem solving, abstraction, generalization verbal identification, and similarity.

Klausmeier, Herbert J. Learning and Human Abilities. New York: Harper and Brothers, 1961.

In expanding Guilford's classification system of psychomotor abilities, Klausmeier has listed for reasons for individual differences in performance: differentiation of cues to guide actions, rate of trial, correction, and confirmation of responses, rate of movement, and coordination of movement.

Martin, Felix. Questioning skills among advantaged and disadvantaged children in first grade. Psychological Reports, 1970, 27, 617-618.

A comparison of the two classes of children indicated that the disadvantaged children seemed to have a lower developmental level of question-asking skills.

Marsh, George. Conceptual skills in beginning reading. U. S. Department of Health, Education, & Welfare, Office of Education, Bureau of Research, 1969.

The stages of the task hierarchy were seen as two broad categories: Information processing techniques, and conceptual skills. Information processing was broadly viewed as multiple discrimination and association: Identification & Differentiation, Production, Generalization, and Abstraction. Conceptual skills included concept of class, information reduction, sequential rules and logical rules.

Kukla, Andy. The cognitive determinants of achieving behavior. Dissertation Abstracts International, 1971, 31, 4365-4366.

The data suggested that high and low achievers attribute causality differently, and that these attributions seem to elicit behavior characteristic of corresponding achievement group.

Meyers, C. Edward; Owens, Earl P.; and McIntyre, Robert B. Utilization of learning principles in retardation. In Koch, R.; and Dobson, J. C. (eds) The Mentally Retarded Child and His Family. New York: Brunner/Mazel, Publishers, 1971.

The authors have identified a number of abilities which differentiate retardates and normals:

1) Ability to produce and/or use word mediators
2) Ability to attach class names
3) Motor skills
4) Language skills
5) Short-term memory
6) Attention

Srager, Rodney W. Cognitive skills: A consideration in evaluating instructional effects. U. S. Department of Health, Education, & Welfare, Office of Education, Bureau of Research, Contract No. BR-6-1646,1968.

A need to refine and standardize measures of cognitive skills is cited as being the first step in relating these skills to learning. Work was then being done at Center for the Study of Evaluation of Instructional Programs.

Miscellaneous References

Introduction

During the search of the literature, a number of references were identified which were deemed relevant to the area of general learning abilities. That is, several references related to the facilitation of learning, but they could not be fit easily into the scheme selected for organizing the literature. Thus, this final section of Part II may appear to be rather unorganized. However, even these miscellaneous references have been organized into the Role Affective Variables, Personality Variables, Experiential Variables, Age Variables and General Views.

Bibliography

Krathwohl, David R.; Bloom, Benjamin S.; and Masia, Bertram B. Taxonomy of Educational Objectives: The Classification of Educational Goals - Handbook II: Affective Domain. New York: David McKay Company, Inc., 1964.

This taxonomy of outcomes ranging from simple attention to degree of acceptance or rejection emphasized a "feeling" tone. The organizing principle was the degree of "internalization." The basic categories were Receiving, Responding, Valuing, Organization, and Characterization of a value complex.

King, Luanne P. Affective change and cognitive skills. International Reading Association, ERIC No. 052893, 1971.

The position was taken that the schools put too much emphasis on intellect, and do not attend to the development of the "whole student." The Bloom and Krathwohl taxonomies are suggested as a basis for all programs.

Khan, S. B. Affective correlates of academic achievement. Journal of Educational Psychology, 1969, 60, 216-221.

A 122 item instrument measuring attitudes, study habits, etc. was administered to Ss of both sexes. The responses were intercorrelated for the sexes separately and the two matrices factor analyzed. Comparable results were obtained. The inclusion of affective variables

in the system significantly increased the prediction of achievement variables (reading, language, arithmetic computation, problem-solving, social studies, and science) for both sexes. It was suggested that a systematic study of the relationship between affective variables and achievement is necessary.

Athey, Irene. Affective factors in reading. ERIC No. 031377, 1969.

Affective variables were seen as enhancing cognitive skills. Variables discussed included self-confidence, anxiety, accurate perception of reality, autonomy, and attitudes.

Kagan, Jerome, et al. Personality and IQ change. Journal of Abnormal and Social Psychology, 1958, 56, 261-266.

It was concluded that high need achievement, competitive striving, and curiosity about nature facilitate the acquisition of skills measured by intelligence tests.

Ohnmacht, Fred W. Personality and cognitive referents of creativity: A second look. Psychological Reports, 1970, 26, 336-338.

Five measures of divergent productivity and the Myers-Briggs Type Indicator were administered to 90 subjects. On the basis of observed correlations it was concluded that there is no relationship between the cognitive and personality referents of creativity examined.

Zohrer, Inge [On the influence of unpleasant affect experiences on perception learning and thinking.] Zeitschrift für experimentelle und angewandte Psychologie, 1970, 17, 670-686.

Unpleasant affect experiences had a highly significant detrimental effect of perception and learning.

Anderson, R. C. Can first graders learn an advanced problem-solving skill? Journal of Educational Psychology, 1965, 56, 283-294.

An experiment was reported, the results of which suggested that bright children can acquire, retain, and transfer rather complex problem-solving behavior with proper instruction.

Flavell, John H.; Friedrichs, Ann G.; and Hoyt, Jane D. Developmental changes in memorization processes. Cognitive Psychology, 1970, 1, 324-340.

Only older students indicated a specific, fairly complex strategy for memorization when given unlimited time to study a set of items for serial recall.

Moffitt, Alan R. Consonant cue perception by twenty- to twenty-four-week-old infants. Child Development, 1971, 42, 717-731.

Consonant syllables were used and the cardiac response measured. The results suggested that infants can discriminate between "bah" and "gah."

Neumaik, Edith; Stotnick, Nan S.; and Ulrich, Thomas. Development of memorization strategies. Developmental Psychology, 1971, 5, 427-432.

The data from this study were interpreted as evidence that memorization is not an isolated skill, but one of many manifestations of an individual's characteristic age-related approaches to problems.

Zinchenko, P. I. [Formation of methods of logical memorization in first graders.] Dokl. Akad. Pedag. Nauk RSFSF, 1959, 6, 63-66.

The results indicated that first graders cannot use classification skills spontaneously, but that they can be taught to use these skills.

Gardner, Riley W.; and Long, Robert I. Cognitive controls as determinants of learning and remembering. Psychologia, 1960, 3, 165-171.

Studies done at the Menninger Foundation were summarized. Some aspects of individual differences studied were: The selectivity of attention deployment, the field-articulation principle, the habitual extensiveness of scanning under free scanning conditions, and leveling and sharpening behaviors.

Abrams, Jules C. Factors affecting thinking and comprehension skills. ERIC No. 015097, 1966.

Experience and concept formation are viewed as playing fundamental roles in the development of thinking abilities. These, in turn, are influenced by the joint operation of the physical, emotional, and social status of the individual.

Learning to learn program, Jacksonville, Florida. Preschool program in compensatory education. Palo Alto, California: American Institutes for Research, ERIC No. 038472, 1969.

A program was designed to help children acquire flexible strategies for dealing with problems. This report describes the program.

PART III

A PROPOSED ORGANIZATION OF HUMAN ABILITIES

Introduction

After reviewing the literature which has been described in Part II of this report, the task became one of searching for some sort of organizational structure which could be used to chart the domain of general human abilities. The most general categorization apparent was that of cognitive-perceptual motor-physical. Beneath this level several broad processes emerged from each of the three classes. These processes were particularly visible in the extended research programs of Guilford and Fleishman. Borrowing heavily from the work of these two men, and employing some preliminary organizational principles and definitions from Theologus and his associates, the following organization of human abilities is proposed. Within each of the three classes (Cognitive, Perceptual-Motor, and Physical) broad categories have been identified and defined. Within each broad category, general abilities have been defined and performances in which they are manifested are offered as examples. A skeletal diagram of the proposed domain is presented in Appendix C.

A Proposed Organization of the Domain of Human Abilities

I. COGNITIVE PROCESSES

A. COGNITION -- the awareness, understanding, comprehension, and/or recognition of information. The information may be in figural, symbolic, or verbal form

1. Verbal Comprehension -- the ability to understand language, comprehension of shades of meaning

Examples: Selecting a synonym
Understanding a simple communication
Understanding the details of an extensive legal document

2. Problem Sensitivity -- the ability to recognize or identify the existence of a problem (figural, symbolic, or semantic)

Examples: Recognizing that a device is broken
Recognizing that a response is inappropriate

B. MEMORY -- the retention or storage of information

1. Memory Span -- the ability to reproduce a series of items after one presentation or after a series of presentations. It is also possible to differentiate between serial recall and free recall

Examples: Reproducing a series of letters after hearing it read
Recalling a phone number

2. Associative Memory (Meaningful) -- the ability to recognize and recall relationships between pairs of items

Examples: Recalling mathematical formulas
Recognizing a specific relationship between items, and applying it to generate new pairs at a later time

3. Associative Memory (Arbitrary) -- the ability to recall item pairs that have no obvious relationship. Each particular item pair must be learned

Examples: Pairing first and last names

C. CONVERGENT PRODUCTION -- the generation of information from given information. The criterion is a unique or conventionally accepted outcome

1. Verbal Expression -- the ability to use language to communicate information or ideas to another person, with the emphasis on the quality of the communication, not the idea

   Examples: Communicating in a conversation
   Writing a letter
   Writing a book

2. Number Facility -- the ability to manipulate numbers in arithmetic operations, with emphasis on speed and accuracy

   Examples: Adding, subtracting, multiplying, or dividing a series of numbers

3. Mathematical Reasoning -- the ability to reason abstractly using quantitative concepts and symbols, including the ability to understand and structure math problems

   Examples: Understanding how to "make change"
   Solving math word problems

4. Deductive Reasoning -- the ability to apply general concepts to specific cases

   Examples: Deriving conclusions from stated premises
   Designing a nuclear reactor using principles of nuclear physics

5. Inductive Reasoning -- the ability to form or find the most appropriate concept or rules which explain sets of data

   Examples: Prediction
   Concept formation
   Developing and testing hypotheses

6. Information Ordering -- the ability to apply rules to information given, in order to arrange that information

   Examples: Seriation
   Classification

D. DIVERGENT PRODUCTION -- the generation of information from given information. The criteria for success include both quantity and variety

1. Ideational Fluency -- the ability to rapidly produce a number of ideas, where the criterion is the number of ideas

Examples: Naming 10 different brands of cars
Giving a number of synonyms for a word
Giving many ideas to be included in an essay of a given title

2. Originality -- the ability to produce unusual or clever responses, where the criterion is the quality of the ideas

Examples: Using a familiar object for a novel purpose
Inventing a new implement or product
Predicting consequences of an unusual event

3. Category Flexibility -- the ability to form alternative classification schemes for a set of items

Examples: Sorting objects on basis of length
Listing 5 different "dimensions" to classify students
Producing rules to be followed in subsequent sorting

E. EVALUATION -- the critical examination of ideas, objects, etc.

1. Evaluation-Internal -- the ability to examine critically a work by standards of consistency, logical accuracy, etc.

Examples: Judging consistency in the use of terms
Judging logical fallacies in a communication

2. Evaluation-External -- the ability to examine critically a work by standards of efficiency, economy, or usefulness for a specific purpose

Examples: Comparing learning theories with respect to how well they "explain" a phenomenon
Judging the predictive validity of a psychological testing procedure

II. PERCEPTUAL-MOTOR RESPONSES

A. SENSORY -- the use of the senses for input and information processing in dealing with stimuli

1. Reaction Time -- the ability to quickly initiate a single motor response after a single stimulus

Examples: Pressing a button in response to a buzzer
Stepping on car brake in response to amber light

2. Choice Reaction Time -- the ability to select and initiate quickly the appropriate response when two or more stimuli are present and the response must be selected from two or more possibilities

Examples: Selecting the correct lane at a complex interchange while traveling on an Interstate highway

3. Speed of Closure -- the ability to rapidly combine and organize a set of apparently disparate stimuli into a single meaningful pattern

   Examples: Identifying numbers seen only very briefly
   Identifying the nature of an ambiguous configuration on a radar screen for air control near airport

4. Perceptual Speed -- the ability to rapidly compare sensory patterns in order to determine identity or degree of similarity

   Examples: Examining pairs of multi-digit numbers, checking for identity
   Rapidly checking invoices for agreement of invoice number and amount

5. Attention -- the ability to carry out a task in the presence of distraction

   a. Perseverance -- the ability to concentrate on the task

      Examples: Working on a task under monotonous conditions

   b. Resistance to Distraction -- the ability to filter out distracting stimuli

      (1) Distraction internal to task

         Examples: Identifying friends in a crowd
         Identifying a toad in a garden
         Finding embedded figures

      (2) Distraction external to task

         Examples: Working on a noisy assembly line
         Reading aloud with unexpected bursts of noise
         Studying for an exam in a noisy room

6. Time Sharing -- the ability to utilize information, shifting between two or more sources of information

   Examples: A baserunner on first watching batter, pitcher and first baseman
   A lifeguard watching children on deck, swimmers, and divers

B. SPATIAL RELATIONS -- comprehension and operation with spatial relationships

1. Visualization -- the ability to manipulate or transform the visual images of spatial patterns

Examples: Anticipating how to put paper in typewriter so that letterhead is in correct place
Imagining a room with the furniture rearranged
Anticipating how a paper, folded and cut, would look when reopened

2. Spatial Orientation -- the ability to comprehend the position of objects in space with respect to the observers position, or to maintain one's orientation with respect to objects in space

a. Comprehension

Examples: Deciding whether pictures of a hand in different positions depict a left or right hand

b. Maintenance

Examples: Using a road map to find your way

C. SPEED OF MOVEMENT -- making of rapid, discrete movements where accuracy and precision are not required

1. Speed of Limb Movement -- the ability to make discrete movements of arms or legs

Examples: Punching a bag of sand in rapid combinations
Stepping on a fast crawling bug

2. Wrist-Finger Speed -- the ability to make movements of fingers, hands, and wrists

Examples: Sending Morse code using finger key
Tapping two plates alternately which are separated by several inches

D. COORDINATION -- coordination of the movement of a number of limbs simultaneously or of the body as a whole

1. Equilibrium -- the ability to maintain or achieve balance

a. Gross Body Equilibrium -- the ability to maintain the body upright

Examples: Walking on railroad track rail
Skiing over rough terrain

b. Object Equilibrium -- the ability to balance objects, etc.

Examples: A waiter balancing a tray of plates
A juggler balancing a plate on a stick

2. Gross Body Coordination -- the ability to coordinate movement of the trunk and limbs

Examples: Making a jump-shot in basketball
Ballet dancing
Jumping rope

3. Multiple Limb Coordination -- the ability to coordinate two or more limbs

Examples: Driving a manual shift automobile
Juggling three balls

E. DEXTERITY -- making skillful, controlled manipulations of arms, hands, or fingers in handling objects of various sizes

1. Manual Dexterity -- the ability to make skillful, coordinated movements of a hand, or hand with associated arm, with or without objects (but never machines)

Examples: Putting cans in boxes as they pass on a conveyor belt
Turning pages of a book
Performing surgery

2. Finger Dexterity -- the ability to make skillful, coordinated movements of the fingers, with or without objects (but never machines)

Examples: Assembling washer and nut and place on bolt
Putting coins in a parking meter
Playing flamenco guitar

F. MOVEMENT DISCRIMINATION -- selecting correct movement from several alternatives or adjusting movement in response to changes in a moving stimulus or target

1. Arm-Hand Steadiness -- the ability to maintain precise, steady arm-hand positioning

Examples: Pointing at a sign
Aiming at a fixed target with a gun

2. Rate Control -- the ability to make timed, anticipatory motor adjustments relative to changes in speed or direction of an object

Examples: Tracking a moving target
Football defensive back covering a potential receiver

3. Control Precision -- the ability to make controlled muscular movements necessary to adjust or position a machine

   Examples: Throwing a switch
   Manipulating controls for lunar landing

III. PHYSICAL PROCESSES

A. STRENGTH -- exertion of a maximum amount of force with any part of the body for a period of time. May be continuous or in repeating bursts

1. Static Strength -- the ability to exert continuously a force sufficient to move a heavy, external object

   Examples: Squeezing a dynamometer
   Pushing a stalled car

2. Explosive Strength -- the ability to expend energy in a burst, or repeated bursts against internal or external objects

   Examples: Throwing a ball (external object) for distance
   Putting the shot (external object)
   High jumping (internal object)

3. Dynamic Strength -- the ability to use arm and trunk muscles to repeatedly or continuously support the body's own weight

   Examples: Doing sit-ups
   Squeezing oranges to make juice

4. Stamina -- the ability to maintain physical activity for a prolonged period of time

   Examples: Climbing a mountain
   Distance running
   Swimming the English Channel

B. FLEXING -- stretching, twisting, or rotating the body

1. Extent Flexibility -- the ability to extend, flex, or stretch muscle groups where the concern is with the degree of flexibility

   Examples: Twisting as far around as possible
   Performing as a contortionist

2. Dynamic Flexibility -- the ability to make rapid and repeated trunk and/or limb flexes

   Examples: Prizefighting
   Ditch digging

APPENDIX A

TOPICS FOR REVIEW

TOPICS FOR REVIEW

Back to 1960

I. Psychological Abstracts

A. Developmental Psychology

1. Childhood

a. Learning
b. Abilities
c. Concepts and Language
d. Perception

2. Adolescence

B. Educational Psychology

1. School Learning

2. Special Education (Gifted, Mental Retardation)

C. Clinical Psychology

1. Attention and Expectancy and Set

2. Learning (all)

3. Thinking

a. Problem Solving
b. Concepts

4. Motivation and Emotion

II. Education Index

A. Abilities

B. Learning

C. Perception

APPENDIX B

TECHNICAL RESOURCES FOR HUMAN ABILITIES

TECHNICAL RESOURCES FOR HUMAN ABILITIES

Individuals:

Arthur Jensen
University of California
Berkeley, California

Edwin A. Fleishman
American Institutes for Research
Silver Spring, Maryland

George C. Theologus
American Institutes for Research
Silver Spring, Maryland

Raymond B. Cattell
University of Illinois
Urbana, Illinois

Institutional:

American Institutes for Research
Palo Alto, California

Research and Development Center for Learning
University of Wisconsin
Madison, Wisconsin

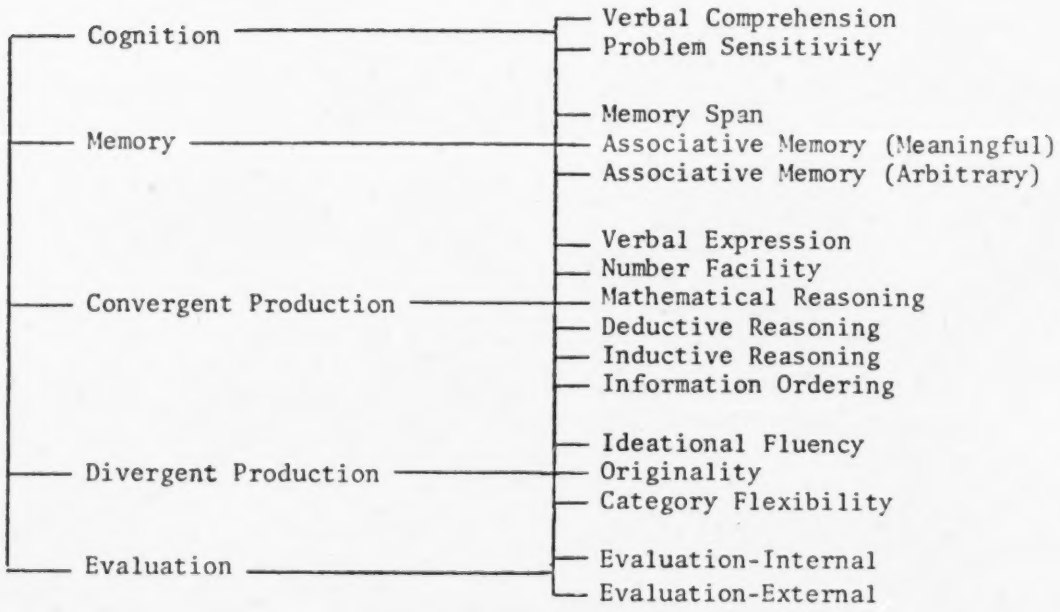
Center for the Study of Evaluation of Instructional Programs
University of California - Los Angeles
Los Angeles, California

Duval County Board of Public Instruction
Learning to Learn Program
Jacksonville, Florida

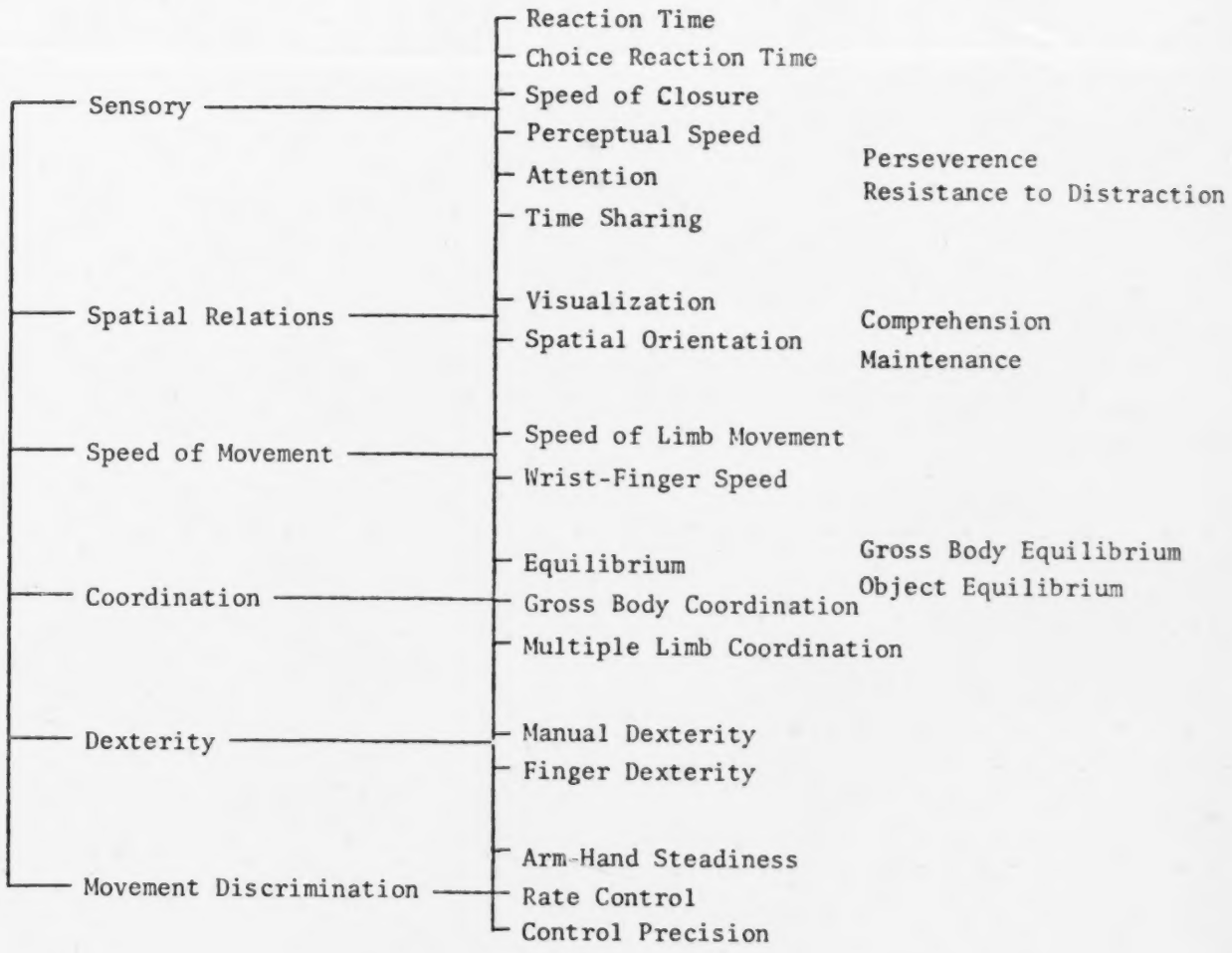
APPENDIX C

DOMAIN CHARTS OF HUMAN ABILITIES

COGNITIVE PROCESSES AND ABILITIES



PERCEPTUAL-MOTOR PROCESSES AND ABILITIES



PHYSICAL PROCESSES AND ABILITIES